THE ROCK OF AGES.

THE nature of science is much misunderstood even by scientists of rank, and as a result theories such as agnosticism, pluralism, pragmatism, humanism, etc., make their appearance. The truth is that the conception of science as a method, as a systematic plan of investigation, as a consistent principle of arranging facts in order, has not as yet become common property among our main investigators, and there is a notion afloat of the haphazard character of scientific research.

Mrs. Fiske Warren, whose article "A Philosophical Aspect of Science" appears elsewhere in this issue, is an instance of this tendency. She studied four years at Oxford, taking the full philosophical course with teachers representing opposing schools of philosophical thought. She is introduced to us by Professor William James who speaks of her in the highest terms.

Mrs. Fiske Warren's conception of science is by no means isolated. In a lucid way she summarizes and ably represents the view common among many scientists, and from this standpoint it almost appears a kindness toward science, this inadequate mode of research, to look upon its future with indulgence and suppress the pessimism of despair. In spite of the many drawbacks of science, Mrs. Warren advocates a conditional optimism which is to comfort us for the loss of our illusion.

Note that in her conception the progress of science "might be described in a series of successes and failures

on an ascending curve; no failure means a total collapse of knowledge, no success is ever complete." Thus she places scientific solutions on a level with haphazard probabilities, but even in doing this she ignores the fact that the simile here used is based on the conception of a mathematical curve which would definitely predetermine the progress of science. The development of science is no less subject to law than the growth of animals and plants, the crystallizations of minerals, yea, the formation of whole solar systems. This does not prove as yet, but indicates, that science is not comparable to any haphazard mode of hitting the bull's eye and does not depend on incidental successes, harboring the failures also in its own nature as if they were part and parcel of science itself and did not belong to the struggles of poor mortal and fallible scientists who fail to attain an insight into her nature.

When Mrs. Fiske Warren calls her position "a philosophical conception of science," I must demur, for I hold that her views are unphilosophical and even antiphilosophical; they are pluralistic. Philosophy has always endeavored to trace the unity of our conception of the world, and a pluralistic philosophy which, while clinging to particulars and to individual facts, denies unity and scorns system as pure theory is practically a surrender of the ideal of philosophical thought and implies, to say the least, a suggestion that science is impossible and that the light of science is a mere will-o'-the-wisp.

METHOD THE ESSENTIAL FEATURE OF SCIENCE.

Science is a method of inquiry and as such it means system. The results of science are systematically formulated universalities, i. e., groups of facts of the same character described in their essential nature, singling out the determinant features and omitting all the rest. Such a formula describing a definite set of facts is called a natural

law, and I will say here incidentally that what Mrs. Warren says concerning the nature of abstraction is quite correct, although she might have better characterized the nature of abstraction if she had borne in mind the significance of the formal sciences, especially logic and mathematics, which play such an important part in abstraction, furnishing the backbone of what we call system in science.

We feel prompted to make a few further comments on the importance of abstraction, for he who truly understands the nature of abstraction can no longer cling to a pluralistic conception either in science or philosophy.

Abstraction singles out some definite features and drops all others. An abstraction is mind-made but it represents a real quality of objective things. People who speak of "empty abstractions" with a view of detracting from their significance know not what they say and only exhibit their own lack of judgment. Abstraction is the scepter with which man rules nature, for by the means of abstraction we recognize the common features of things, classify them as general concepts, and learn to formulate the uniformities of nature, commonly called "natural laws."

The very existence of abstraction proves that generalization is possible and the mere possibility of generalization is an evidence that there are general types, and reason is justified in trusting to logic, arithmetic and mathematics when dealing with facts of the objective world.

Man is the only living being on earth who can make abstractions, for the organ needed to think of whiteness and not of white snow or other white things, to conceive of numbers by counting things and omitting all qualities of the things counted except their presence as items, presupposes the use of words which serve as spoken symbols for things or their qualities and the faculty of making abstractions, of comprising many sense-impressions into general concepts, and of classifying them into a system of

genera and species, is called reason. The speaking animal becomes a rational animal and the rational animal alone can form abstractions, while a methodical use of abstractions establishes science.

A formula describing a definite set of facts is a scientific acquisition which (nothwithstanding Mrs. Warren's statement to the contrary) is a success, complete in its special field. The three Kepler laws, for instance, are a definite and complete solution of the problem of the movements of heavenly bodies. While it is true that the attempts to interpret these facts of nature were failures, of which many were by no means a "total collapse of knowledge," it would be a great mistake to imagine that Kepler had only succeeded in a limited way, and that we had to wait for further facts in order to verify his three laws, or even to expect them to be upset or at least modified by our increase of knowledge.

Science is not a collection of more or less verified hypotheses. It is not an aggregate of mere probabilities. Science is a method of determining the truth, and in spite of the many gaps in our comprehension it offers us a well guaranteed fund of knowledge.

It is characteristic of a conception of science such as underlies Mrs. Fiske Warren's presentation of the case that no distinction is made between theory and well ascertained knowledge of facts. Note the instances which our author adduces to prove her case. She selects for the purpose a brief review of the vicissitudes of the history of matter, a problem which even to-day is not yet ripe for solution. She presents to us a number of hypotheses, not to say vagaries, of prominent scientists.

THEORIES AND TRUTHS.

Newton formulated the law of gravitation in his *Principia,* and this is Newton's immortal work, but otherwise

his significance as a scientist is greatly overrated. Bear in mind Schopenhauer's strictures[1] that Newton's fame is based on the statement of a theory which was first pronounced by Hooke, whose claim in this case he ignored with persistent narrowness.[2] Note Newton's childish ideas concerning the meaning of the Revelation of St. John, his exaggerated high opinion of these his theological views, and you will understand that his notions concerning the ultimate constitution of matter cannot be treated seriously as possessing any scientific value. They are theories based upon insufficient data, or we might almost say on pure imagination. Though Newton's *Principia* is of great importance as a definite formulation of the solution of a problem which had been matured in his time, to present his views of matter as a contribution to science is quite misleading.

When Lord Kelvin visited America he was interviewed by a sage newspaper reporter who wanted an authoritative statement concerning his view of the vortex theory, and Lord Kelvin who had probably been often bored by similar requests simply answered, "It is a mere theory," and so the reporter indulged in extravagant language as to the modesty of the English scientist who spoke of his most famous discovery as a mere hypothesis. The truth is that it was a mere hypothesis, for it is not yet a formula covering facts. It is the attempt to explain certain facts for which we have not yet enough data. That Lord Kelvin's theory is not only ingenious, but that it is very helpful, is conceded by all who utilize his suggestion as a working

[1] *Welt a. d. V.*, I, 25; II, 58, 86 (2d ed., 88). The dispute anent the priority of the invention of the integral in mathematics might find a true solution in the proposition that the first idea came from Leibnitz's fertile brain, to whom it was suggested by his monadology, the theory of infinitesimal particles, while Newton appears to have applied it to the computation of gravitating bodies and thus reduced it to exact mathematical concepts. Dühring in his *Kritische Geschichte der Philosophie*, pp. 353, is inclined to side with Newton against Leibnitz.

[2] See *Enc. Brit., s. v.* "Newton," XVII, 440 ff.

hypothesis and to speak of it as "moribund," creates the suspicion that Mrs. Warren has not grasped its real significance.

There is a difference between theory and truth which is this: A theory is a tentative statement of a truth; it is a working hypothesis, temporarily made and awaiting verification, while a truth is a description of a certain set of features or of an interrelation of phenomena which covers the entire range of facts.

THE LAW OF CAUSATION.

As an important misconception we will mention Mrs. Fiske Warren's interpretation of causality. She speaks of "the law of causality" as "gradually being excluded from science, which more and more contents itself with description." She says, "it still has a respectable reputation. But is it an accurate law? What it asserts is this: Reproduce all the conditions of a certain phenomenon, that phenomenon will reappear." It would lead too far to here renew the discussion of the law of causality. I will only refer to former expositions of mine, especially in discussions with Professor Ernst Mach.[3]

The law of causation has not been replaced by description. It has always been description, except that the term "description" was not introduced until Kirchhoff defined mechanics as an exhaustive and concise description of motion. What Kirchhoff eliminates is the notion of metaphysical factors behind motion, which have sometimes been dignified with the name "cause," but the scholars who used this metaphysical name "cause" did not mean cause at all; they meant "reason," and their notion of reason was based on a distorted view of natural law which then

[3] *The Surd of Metaphysics*, pp. 119-130. Cf. "Mach's Philosophy," *Monist*, XVI, 350-352. See also *Fundamental Problems*, 79-109; and *Primer of Philosophy*, 137-172. For a treatment of the Hume-Kantian problem of causation, see *Kant's Prolegomena*, especially pp. 198 ff.

was not conceived as a uniformity but as a metaphysical entity behind phenomena.

In former discussions of the problem of causation I have pointed out that "a cause" is always a motion, an event, an occurrence, which in a system of conditions changes the arrangement, and results in a new state of things commonly called "the effect." Accordingly the law of cause and effect is the law of transformation. It describes a series of successive changes, the start of which in the system of our investigation we call "a cause," the end "an effect"; and it goes without saying that the effect in its turn may again be a cause, and we thus have a succession of changes which represent causes and effects in an interlinked concatenation.

Without going into further details, I will only say that Hume's famous investigations of causation have missed the mark in so far as he defined cause and effect as "objects following each other," instead of treating them as two phases of one and the same process; thus he could not understand the necessary connection between strychnine and the dead mouse.

After all, the law of causation is not being excluded from science. It is nothing more nor less than another aspect of the famous law of the conservation of matter and energy.

Speaking of the law of the conservation of matter we must bear in mind that matter is to be used in the more general sense of substance, not in its limited definition of mass and volume; for certain facts, now well established, teach us to look upon ponderable matter as subject to origin and destruction. We have reasons to assume that new matter originates in some nebulas of the starry heavens, in due succession of the Mendeljeff series, according to their atomic weight, while the discovery of radium suggests a final dissolubility of chemical atoms. The new view does

not upset the law of conservation of substance, for we assume that the elements thus formed in the celestial retorts of nebulas are due to a condensation of the ether, or whatever name we may give to the primordial world-stuff.

POINTS OF REFERENCE.

If the law of causation were really what Mrs. Fiske Warren says it is, viz., "Reproduce all conditions of a certain phenomenon, that phenomenon will reappear," it would be useless even as a working hypothesis; for, as Mrs. Warren truly explains, we can never reproduce the very same conditions the second time, and this she proclaims in the most exaggerated terms in spite of her former explanation of the significance of abstraction. Our method of science consists in eliminating all accidentals and confining the attention to essential features. In order to prove her case she, following the example of Poincaré, points out some accidental features and thus shows that the repetition of the same event is impossible.

Poincaré here makes the same mistake into which Herbert Spencer falls in his *First Principles,* where he attempts to prove that the simplest phenomena of motion are unknowable. He succeeds only by a blunder. He omits the first essential condition of describing a motion,—he leaves out a point of reference. If a captain walks on deck of his ship, from east to west and the ship is moving in the opposite direction at the same rate, is he moving or standing still? This conundrum is produced only by muddling up the issues and projecting our own confusion into the world of objective facts. If I promise to return to the Pantheon in Paris on a certain day and hour, I mean that place with reference to our geography and not the very same spot in the solar system or even the stellar universe. The very definition of the hour and day implies incidentally

a changed position of the earth with reference to the sun, and the identity of the spot is determined by the accepted meaning of language; the introduction of astronomical relations would be mere quibbling.

THE STABILITY OF TRUTH.

In conclusion I will say: It is not true that "over and over again the fundamental 'truths' have been superseded and buried under fresh growth." The real truths of science, the uniformities of nature, are descriptions of the essential features of certain sets of facts, methodically systematized. They are never superseded, but each of them constitutes a κτῆμα ἐς ἀεί, a possession that has come to stay, and which will be useful as a foundation for further inquiry.[4]

The reason why there is a lack of appreciation of the systematic nature of science, is most likely due to a lack of philosophic training, which in its turn is due to the prevalence of metaphysical and other faulty philosophies such as are sometimes taught even in the foremost and most renowned universities. In order to understand the systematic character of science we must learn to appreciate the paramount significance of form and formal thought, for here lies the real problem of the foundation of science.

The formal sciences give us a key to nature; they enable us to construct systems of reference which can be utilized for describing events under observation in terms of measuring and counting, or, generally speaking, by a description of their formal relations. The formal element in thought as well as in objective reality is the connecting link that overbridges the chasm between subject and ob-

[4] A summary of the author's view is stated very briefly in the introduction to the little book *Philosophy as a Science,* published by the Open Court Publishing Company.

ject and which furnishes us with the key by which we may scientifically comprehend nature.

The view here presented appears to me as the only tenable interpretation of the nature of science. Neither the extreme empiricists nor the Kantian school have offered a satisfactory solution. The empiricists who are at present in the ascendancy fail to see the systematic nature of science, and the Kantian school had the misfortune of finding a wrong expounder to the English speaking world in the philosopher Hamilton. His misconstruction of the Kantian *a priori* changed the Kantian school in England into a metaphysical philosophy involving some inferences which were quite foreign to Kant himself.

The empiricists on the other hand, having a wrong conception of Kant's *a priori*, lost the truth of his philosophy, and instead of understanding the nature of certitude, of consistency, of a systematic method, they produced a kind of evidence by accumulation of details, thereby missing the essential and characteristic point of science. The only foundation of science is to be sought in a philosophy of pure form.

SYSTEM THE AIM OF SCIENCE.

System is the backbone of science, and system is the result of the formal sciences. The latter have been gained through abstraction and constitute what is commonly called "reason." The purely formal aspect of things makes it possible to create purely formal systems of thought such as arithmetic, geometry, and logic. They are *a priori* in the Kantian sense. They are subjective or purely mental, but serve as models for any object of investigation, be it purely imaginary or actual, merely possible, potential or real, and thus they can be used as means of reference for describing any existence, real or imaginary, which is dominated by consistency. Consistency in the realm of the

purely formal sciences produces that wonderful harmony which we observe for instance in mathematics. Consistency in nature produces what in a former article we have called lawdom,[5] a state of things called in German *Gesetzmässigkeit,* which makes it possible for certain facts of the same class to be described as uniformities. Consistency in action renders possible the rationality of living creatures, enabling them to exercise choice, to make plans, and carry out purposes.

Though many scientists look upon science, in the light of Hume's skepticism, as the result of good chances, of mere lucky haphazard successes, there is developing in the present age a deeply rooted confidence that science is more than the result of accidental guesses, and we believe that we have produced the evidence of the attainment of scientific certitude, the foundation of which is laid in the philosophy of form.

But this confidence is of a broader nature and of a more ancient date than is commonly granted. This same confidence has accompanied man from the dawn of his rationality and has found expression in his religion. The world was never a chaos to man, but always the law-ordained cosmos, and this feature of cosmic order was pictured in man's religion as a belief in a divinity of some kind, mostly as a hierarchy of gods, and, in the theistic stage of religious development, simply as God.

Religion accordingly appears in this conception as an instinctive formulation of a trust in the world-order, and this world-order, which the philosophy of form has been able to trace, constitutes the bed-rock of all our thoughts and aspirations in religion as well as in science. In this sense we can truly say that here lies the Rock of Ages.

EDITOR.

[5] See *The Monist,* XX, p. 36.